Space Weather Technical Forecast

Issued on Monday, 21 August 2023 at 13:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares (R1-R2; Minor-Moderate radio blackouts). Coronal Hole high speed stream (HSS) influence likely waning.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Low, with the peak flare reaching C4.3 at 21/0753 UTC from a region just over the southeast limb. There are currently eight sunspot regions on the facing side of the Sun. AR3407, now Dsi/Beta, remains the most complex region but shows limited activity in recent hours. The recently numbered larger AR3413 region continues appear over the eastern horizon in the northern hemisphere. This is perhaps the returning Ex-AR3386 that was responsible for an X1.6 flare on 05 August, though at this stage the regions continues to appear relatively simple and stable. A small new region developed in the southeast disk, and the small AR3404 region waxed and waned. Otherwise there was little change to the other pre-existing regions which remain generally simple and stable.

No Earth-directed CMEs were observed during the period.

Solar Wind / Geomagnetic Activity: The solar wind as measured by DSCOVR and ACE at L1 has been Elevated to Strong throughout, between 580-620km/s with a peak of 690 km/s noted. This initially was thought to be due to the influence of CH35/-, but after further analysis of current and past coronagraph imagery suggests a previously unidentified trans-equatorial, negative polarity coronal hole currently located around 60W. The density of particles carried by the solar wind was mainly at below average levels, with a brief peak of 5ppcc (average) recorded at 20/1958 UTC. The phi angle was accordingly almost exclusively negative (towards the Sun) but became increasingly variable by the end of the period. The magnetic field, IMF (Bt) was Weak to Moderate at the start of the period with a peak of 8.5nT at 20/1810 UTC, with a slowly declining trend thereafter. The north-south component, Bz, ranged weakly between +6 and -6nT, with a slight positive bias overall. The net result of the above solar wind measures was for Quiet to Unsettled geomagnetic activity (Kp2-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels. GOES16 high energy (greater than 2MeV) electron flux ranged from Moderate to Normal Background levels, with the associated 24-hour fluence well below the Active level, with an observed value of 1.26e6 integrated pfu at 21/0001UTC, on a flat then generally declining trend.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar Activity is expected to be mainly Low, but with a Chance of isolated M-class flares. There is a greater chance of activity this week compared to last with the arrival of some far-sided regions.

Solar Wind / Geomagnetic Activity: Solar winds at L1 are currently enhanced at Elevated to Strong levels likely due to a previously unidentified negative polarity, trans-equatorial CH in the western hemisphere. The connection to this feature expected to ease in the next couple of days

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(to Elevated or Slightly Elevated levels) before the arrival of another CH on Day 3 (23 August) likely increases speeds to more persistently Elevated levels once again. This feature then probably eases on Day 4 (24 August). No Earth-directed CMEs feature in the forecast. Geomagnetic activity is forecast to be mostly Quiet to Unsettled (Kp1-3) throughout, but on Day 1 (21 August) and also Day 3 there is the Chance for isolated Active intervals and a non-zero risk of a G1/Minor Storm period should there be any protracted period of negative Bz on these days, especially given the enhanced solar winds indicated.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels. High energy electron flux (greater than 2MeV) will probably show an increase in the coming days as the HSS from the current CH likely wanes, with diurnal peaks reaching Moderate, possibly High values. Confidence in the forecast reduces from Day 3 (23 August) onwards with a new CH expected to reduce electron counts, probably continuing into Day 4 (24 August). The associated 24-hour fluence will start below Active (1e8 integrated pfu), but with a probable upward trend in coming days giving a Slight Chance of reaching the Active threshold on Day 2 (22 August), increasing to a Chance on Days 3 and 4 (23 and 24 August).

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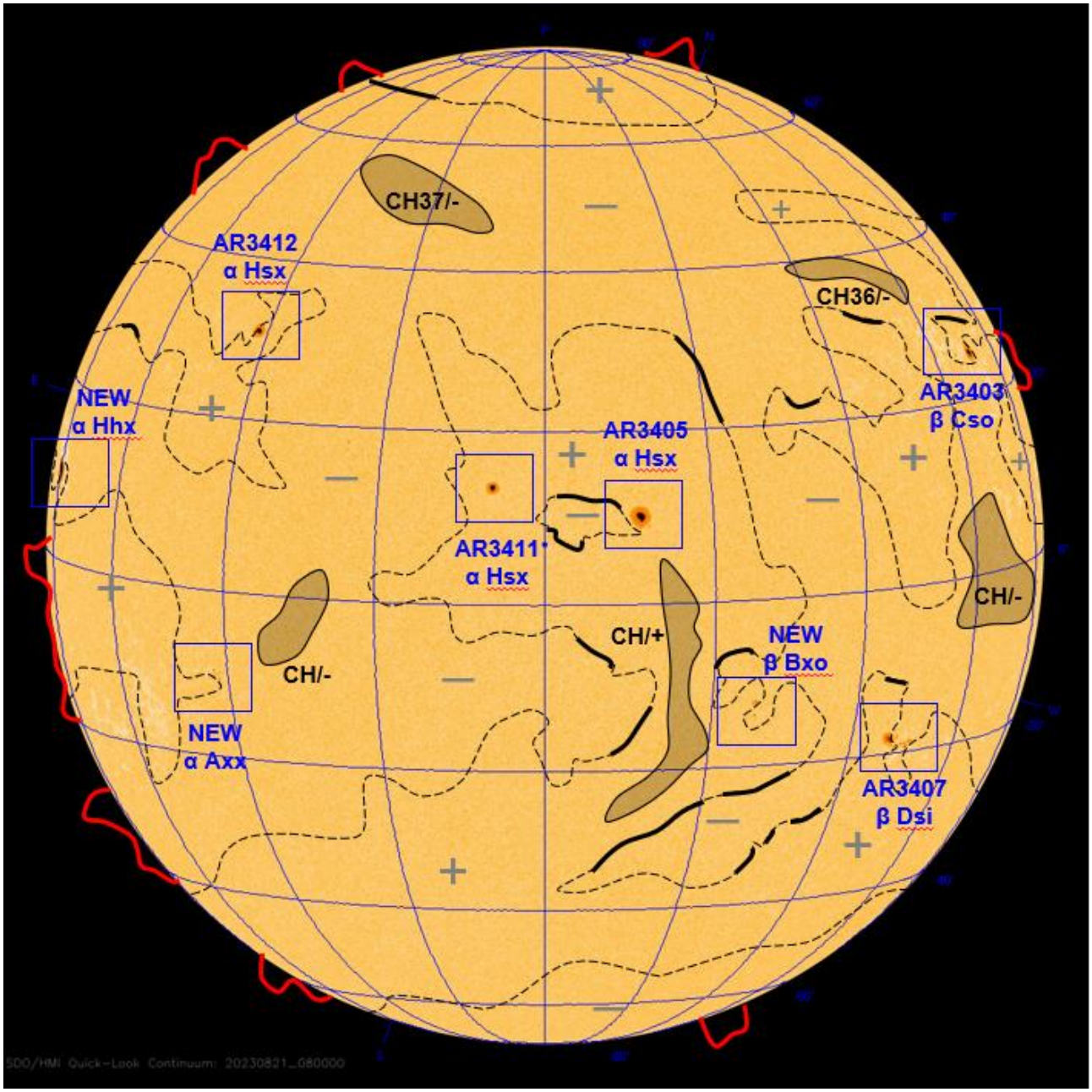
Figure 1. Solar Analysis Valid 21/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs currently feature in the forecast period. However, a large number of filaments occupy the Earth-facing disc of the sun and will be closely monitored for any destabilisation and potential lift-offs during the upcoming days.

Solar winds observed at L1 remain Elevated to Strong with speeds around 600 km/s and a peak speed of 690km/s observed at 20/1200 UTC. It is likely that this is due to the connection to a previously unidentified, negative polarity, trans-equatorial coronal hole around 60W. The duration of the connection to this newly identified feature is somewhat uncertain, but should be at or near its peak effect at L1. A gradual exit from this high speed stream (HSS) is expected in the coming days with speeds currently expected to return to Elevated or Slightly Elevated levels by the end of Day 2 (22 August). It should be noted that Enlil does not feature this HSS in its modelling and as such is unreliable in its forecast detail during the current period.
Following this the next recurrent HSS is a positive polarity coronal hole currently located around 15-20W, extending across the solar equator, but chiefly in the southern hemisphere. This region is of large latitudinal extent, but very narrow longitudinal width. As such, confidence in the onset and duration of any connection to this feature is rather low but speeds of 500-570km/s (Elevated) were observed on the previous rotation and with the region appearing broadly similar. The most likely arrival time of this feature is on Day 3 (23 August), but its influence at L1 should start to weaken again on Day 4 (24 August). Enlil is also largely failing to capture this HSS in its forecast for the period.

Geomagnetic activity is therefore forecast to be mostly Quiet to Unsettled (Kp1-3) throughout, but on Day 1 and also Day 3 there is the Chance for isolated Active intervals and a non-zero risk of a G1/Minor Storm period should there be any protracted period of negative Bz, given the enhanced solar winds indicated.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil

Figure 2: SDO/AIA 211 imagery from 21/1159 UTC. Circled is the previously unidentified CH region thought responsible for the current Strong solar winds.

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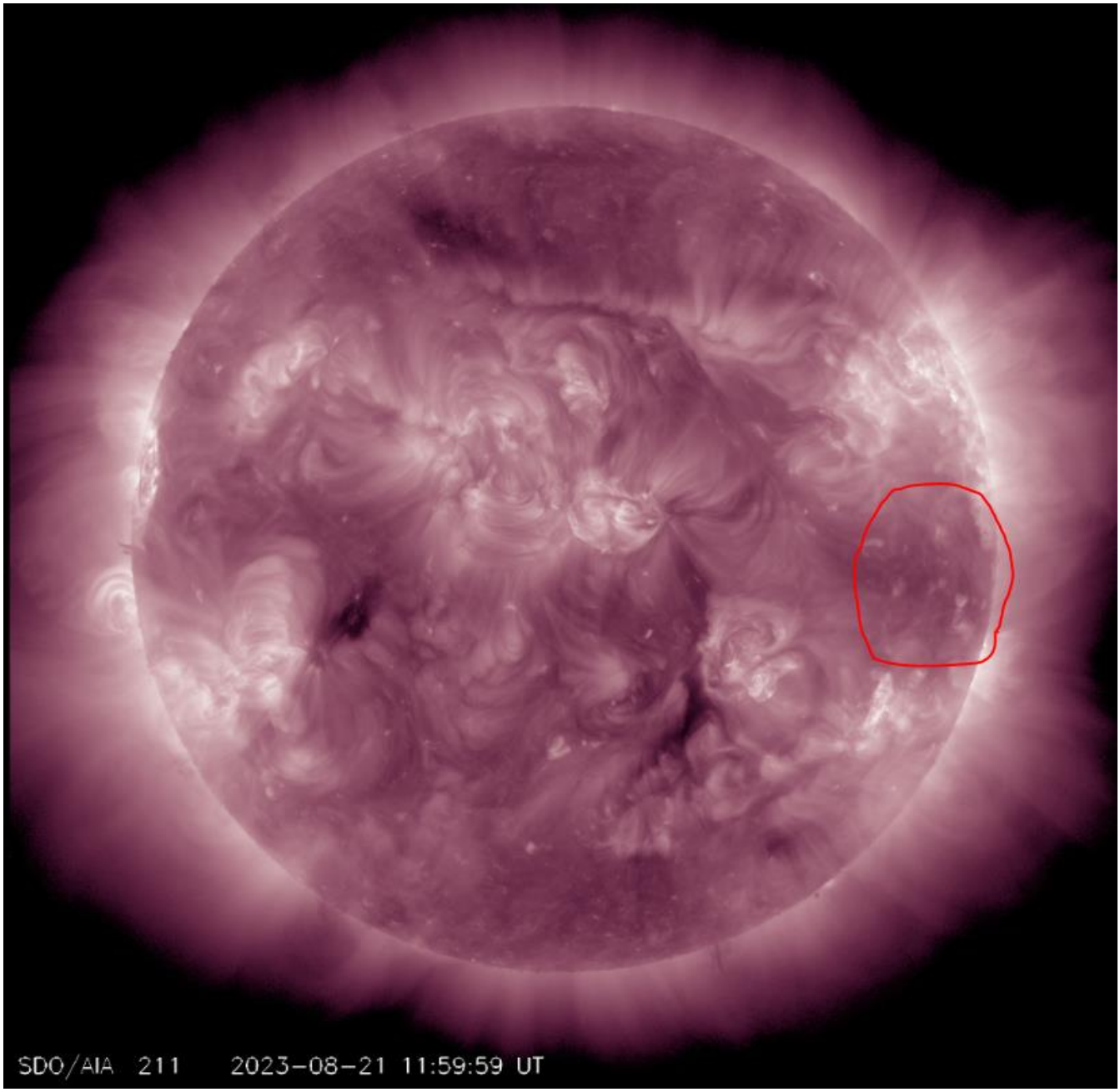

Figure 3: Latest Enlil output from MOSWOC. Notice that observed winds are around 200km/s faster than modelled. An indication that the current HSS is not being accounted for, nor the reccurent feature expected on Day 3 and 4 (23 and 24 August).

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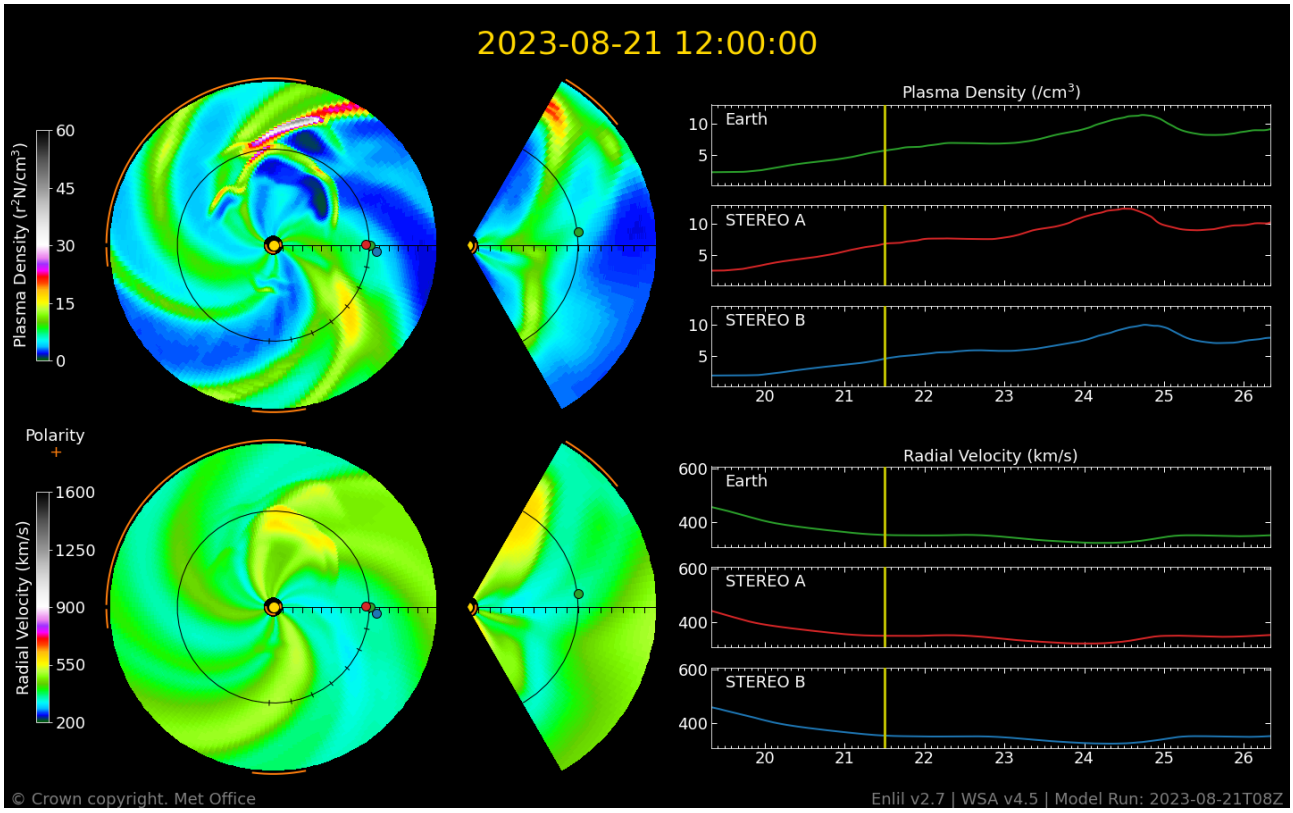

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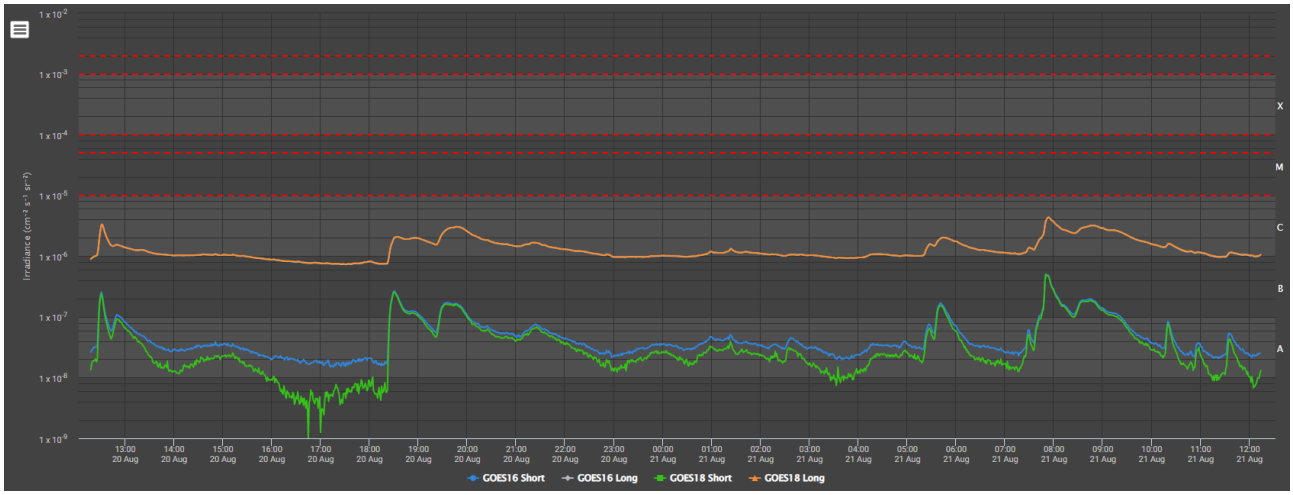
Radio Blackouts - X-Ray Flares:
Solar activity is currently Low, with occasional mid-level C-class flares, peaking at C4.3 at 21/0753 UTC from a region just over the southeast limb. The 10.7cm Penticton flux value is now relatively low at 146sfu (from a midweek high of 160) but is expected to rise with enhanced flux arriving over the eastern solar horizon in the coming days. This is likely to dictate a forecast uptick in activity into the new UTC week, despite the loss of AR3403 and AR3407 over the western limb.

Eight sunspot regions currently feature on the visible disc, with one small un-numbered region in the southeast. The recently numbered larger AR3413 region continues appear over the eastern horizon in the northern hemisphere. This is perhaps the returning Ex-AR3386 that was responsible for an X1.6 flare on 05 August, though at this stage the regions continues to appear relatively simple and stable. Another region just over the eastern limb presents some bright flux on EUV imagery in the southern hemisphere around 20S and may contain another sunspot group though this appears to be a non-recurrent feature.

Solar Activity is expected to be Low, but with a Slight Chance of isolated M-class flares. With the potential for flares from the new regions currently, or shortly, rotating over the eastern horizon balancing with the loss into days 2 and 3 of regions AR3403 and AR3407 currently providing the bulk of the flare risk.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	25	25	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 4: Latest 24hr X-Ray Trace



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Solar Radiation Storms - (High Energy Protons):
High energy (greater than 10MeV) proton flux observed by GOES16 is expected to remain at Background levels. There persists an ongoing Slight Chance of proton flux increases from any significant flares, perhaps most likely from the western solar hemisphere, however these are considered very unlikely to reach S1 Minor Solar Radiation Storm levels.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
The high energy (greater than 2 MeV) electron flux remains close to Normal Background levels. A potentially strong recovery in flux at GEO is possible as the HSS from the newly determined CH/- in the western hemisphere likely wanes during Days 1 and 2 (21 and 22 August), given the current lack of any significant geomagnetic activity. Current guidance is for diurnal peaks to reach Moderate, possibly High levels. Confidence in the forecast reduces by Day 3 (23 August) with the forecast onset of a positive polarity CH that could reduce electron counts at GEO, continuing into Day 4 (24 August) should geomagnetic activity increase as anticipated. MOSWOC REFM modelling does not account for current HSS enhancement this in the forecast, and is currently not preferred. The associated 24-hour fluence forecast is expected to start below the Active (1e8 integrated pfu), but with a probable upward trend between Days 1-3, with possible increased geomagnetic activity later in the period allows electron fluence to reduce again, but all with lower than average confidence.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	10	30	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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